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(54) **Vibration preventing device**

(57) A device for preventing vibration of the rotary drum of a cleaning machine which has a plurality of sealed chambers 23 fitted to a driven washing drum 21, comprises, a detecting means 25 for detecting the vibration of said washing drum and a fluid feed controlling means 32, 33 for feeding predetermined amounts of a fluid selectively to predetermined sealed chambers 23, on the basis of the results detected by said detecting means 25 in synchronism with a position detector 28 responsive to position markers 24 corresponding to the chambers 23.

FIG. 13

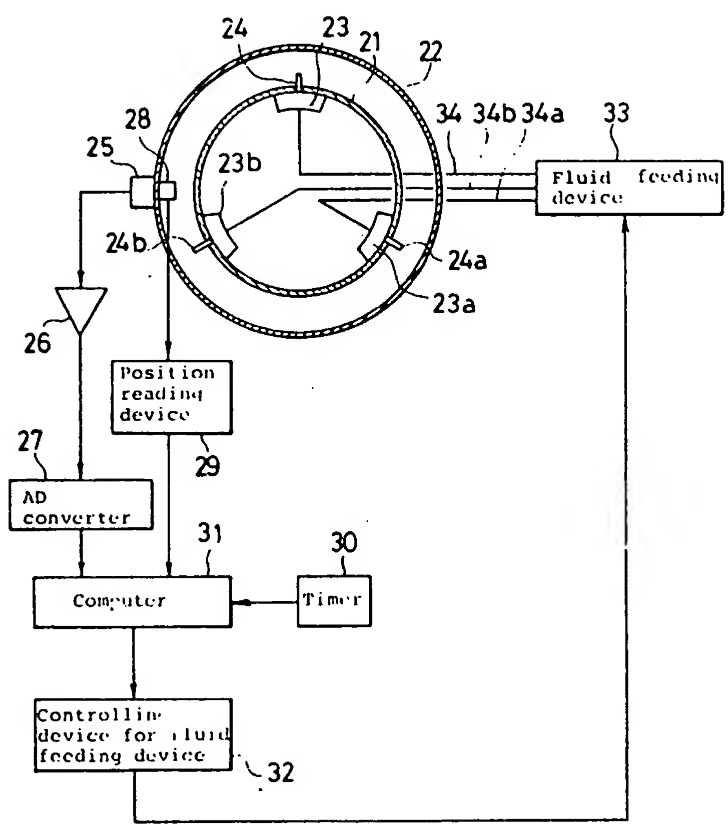

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FIG. 1

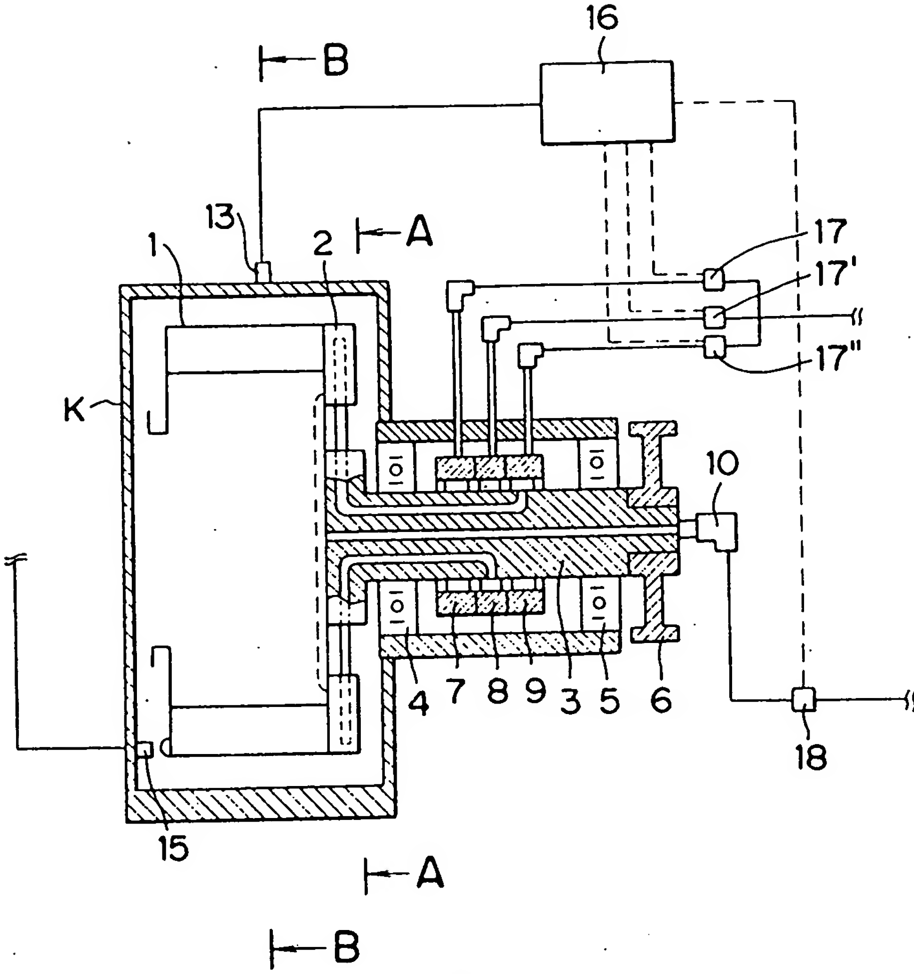


FIG. 2

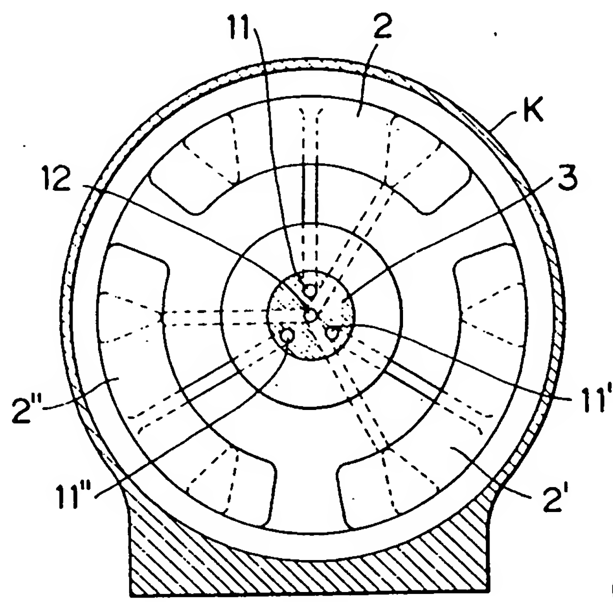


FIG. 3

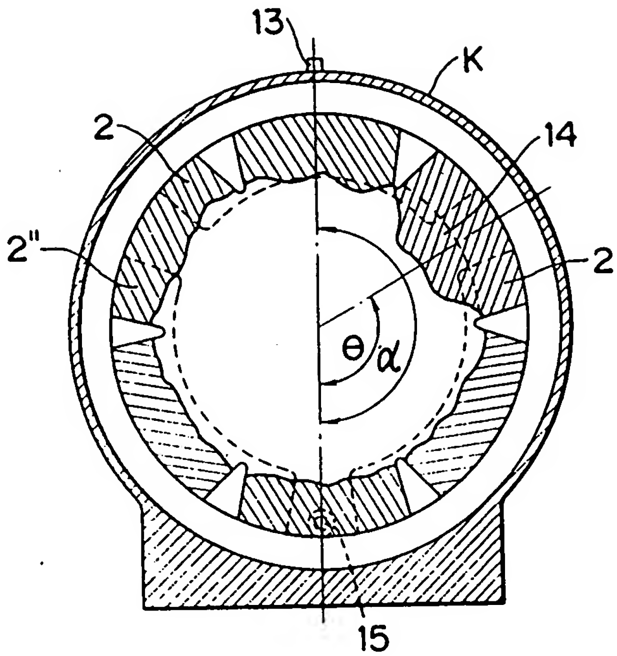

13
K
2
14
2''
2
θ
α
15

FIG. 4

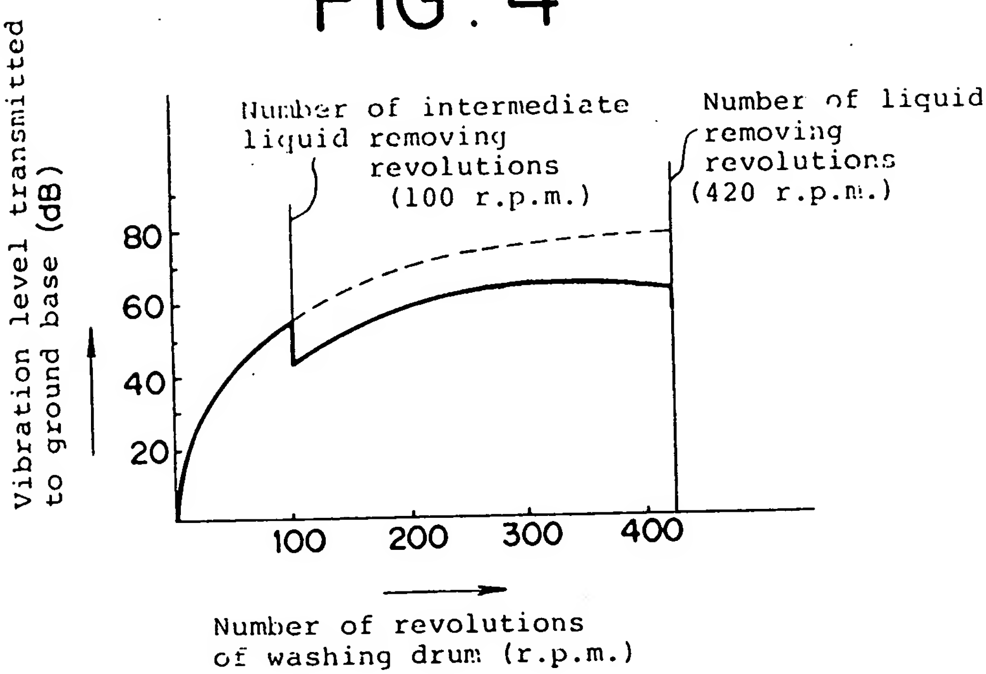

Vibration level transmitted to ground base (dB)
80
60
40
20
Number of intermediate liquid removing revolutions (100 r.p.m.)
Number of liquid removing revolutions (420 r.p.m.)
100
200
300
400
Number of revolutions of washing drum (r.p.m.)

FIG. 5

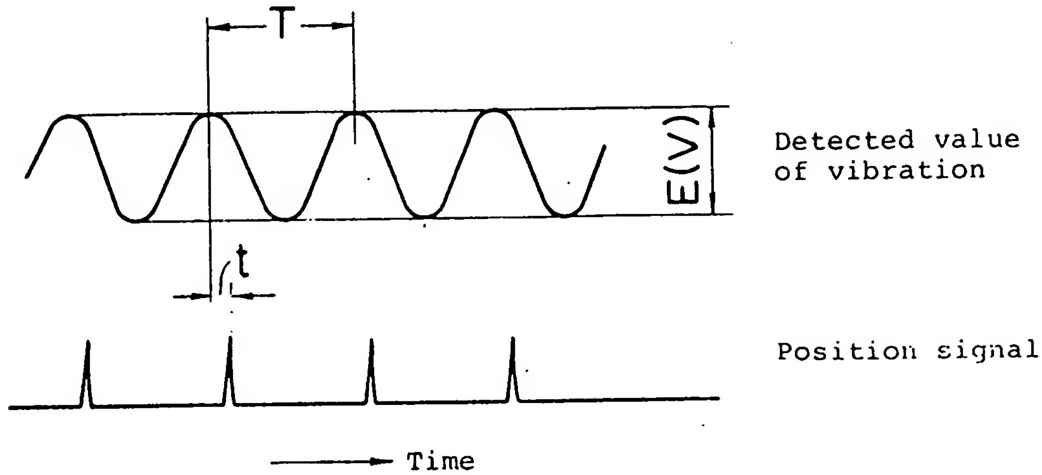


FIG. 6

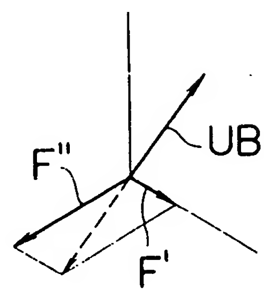


FIG. 7

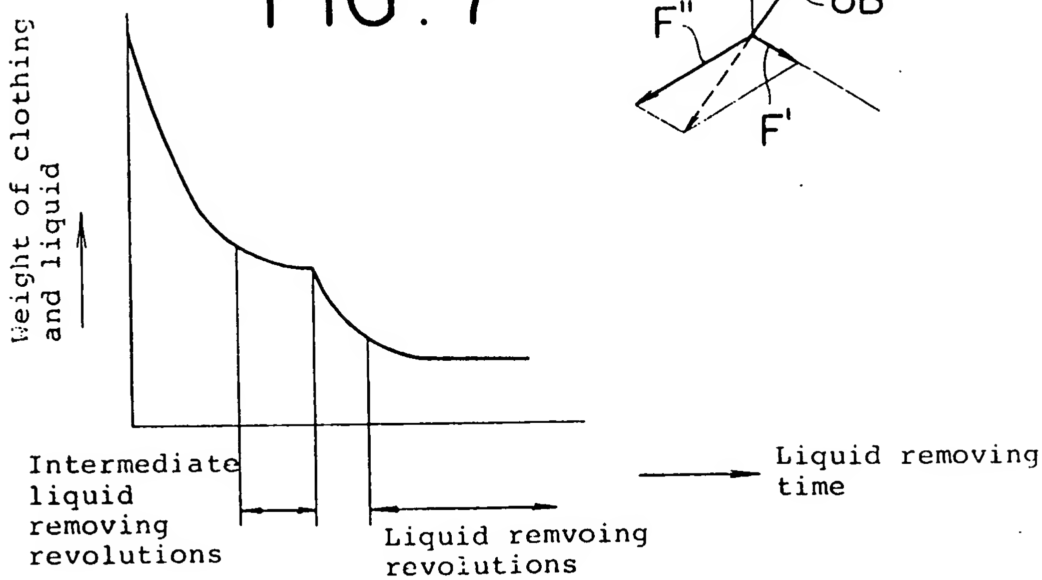


FIG. 8

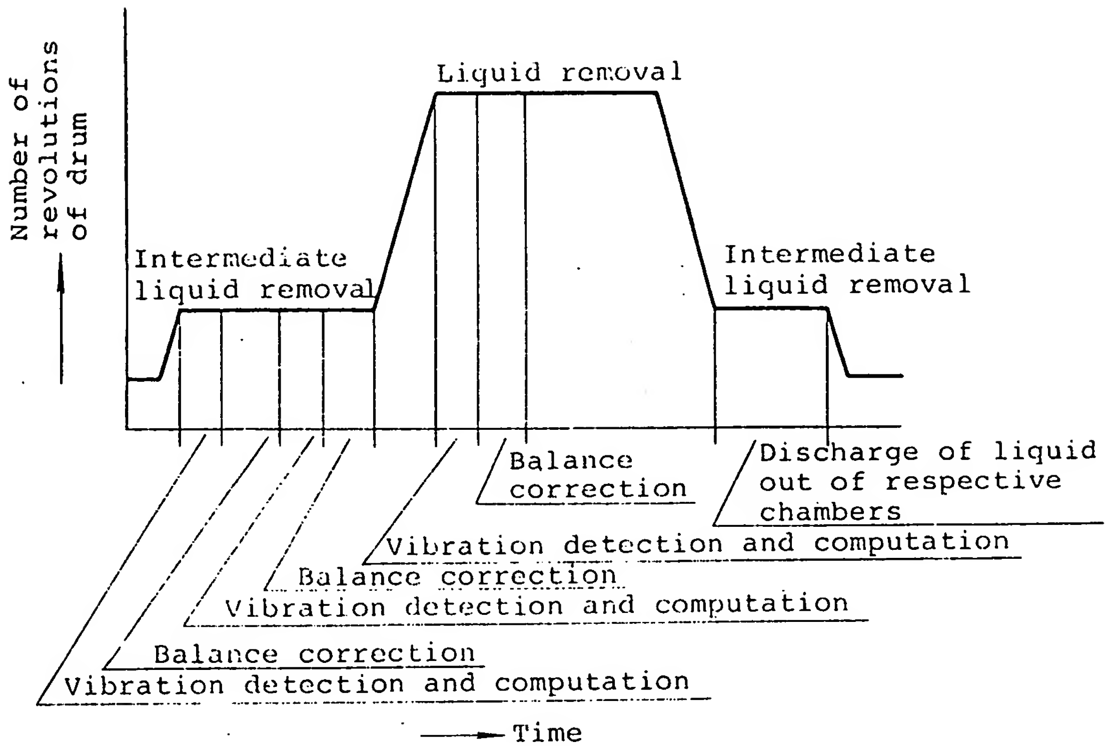

Number of revolutions of drum
Liquid removal
Intermediate liquid removal
Intermediate liquid removal
Balance correction
Discharge of liquid out of respective chambers
Vibration detection and computation
Balance correction
Vibration detection and computation
Balance correction
Vibration detection and computation
Time

FIG. 9

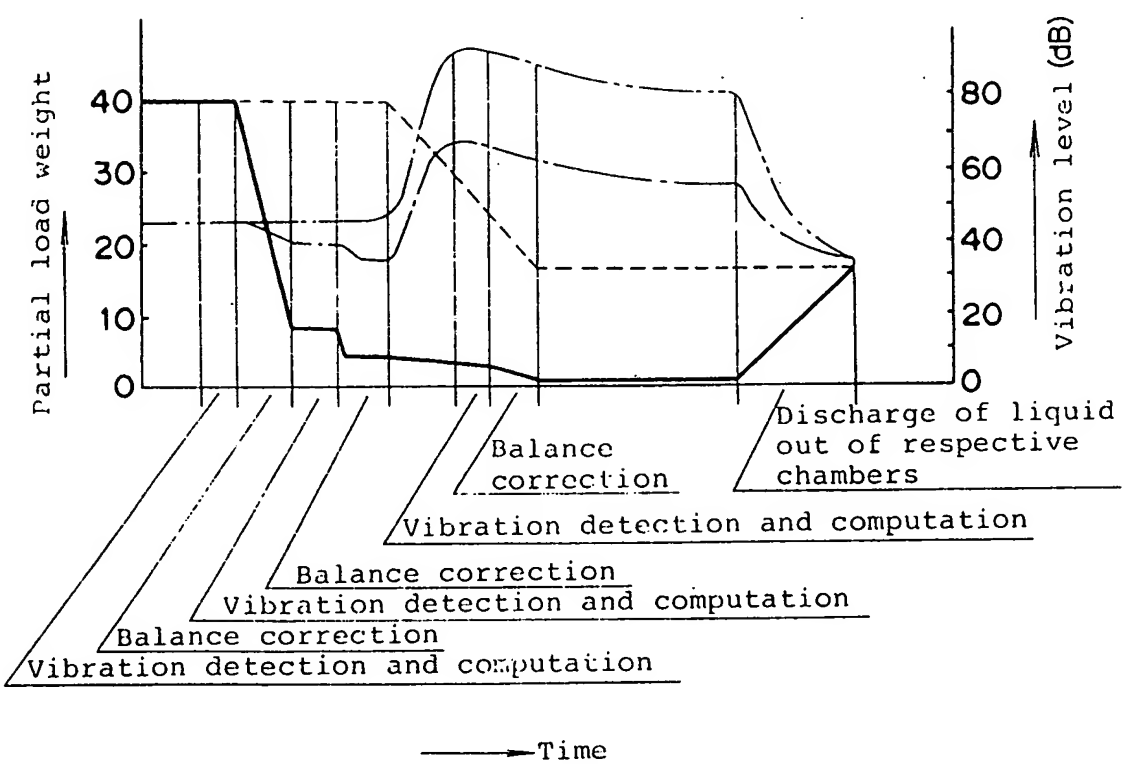

Partial load weight
40
30
20
10
0
Vibration level (dB)
80
60
40
20
0
Balance correction
Discharge of liquid out of respective chambers
Vibration detection and computation
Balance correction
Vibration detection and computation
Balance correction
Vibration detection and computation
Time

FIG.10

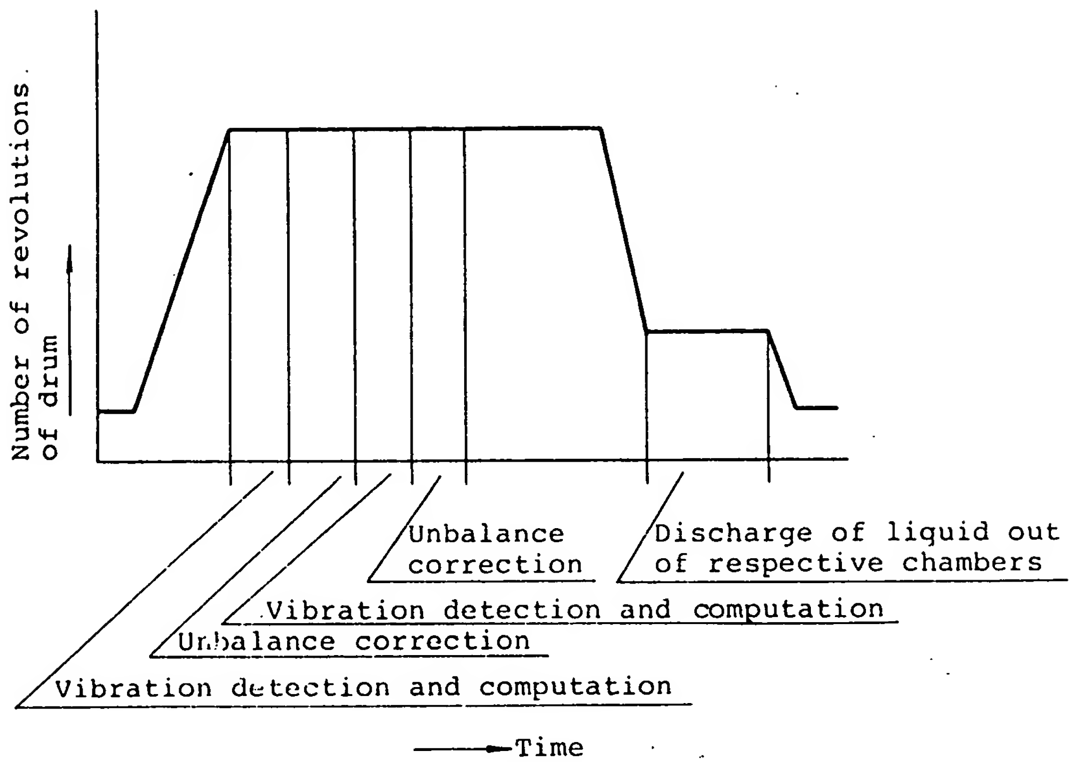

Number of revolutions of drum
Unbalance correction
Discharge of liquid out of respective chambers
Vibration detection and computation
Unbalance correction
Vibration detection and computation
Time

FIG. 11

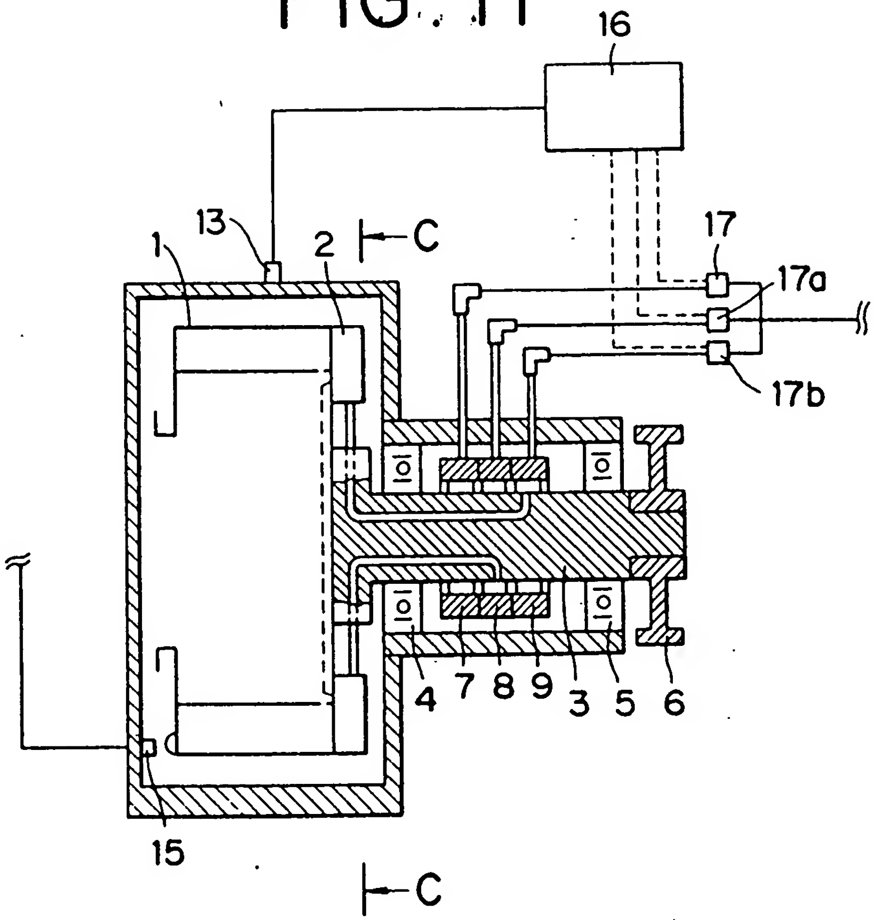


FIG. 12

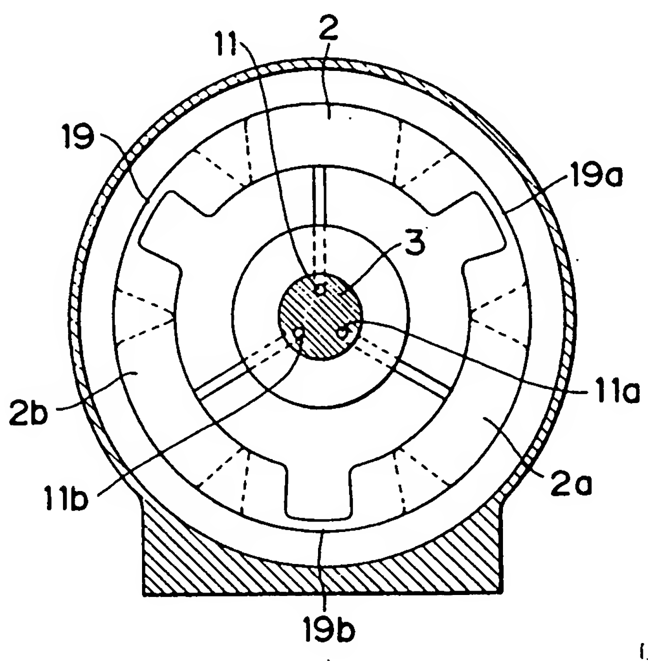


FIG. 13

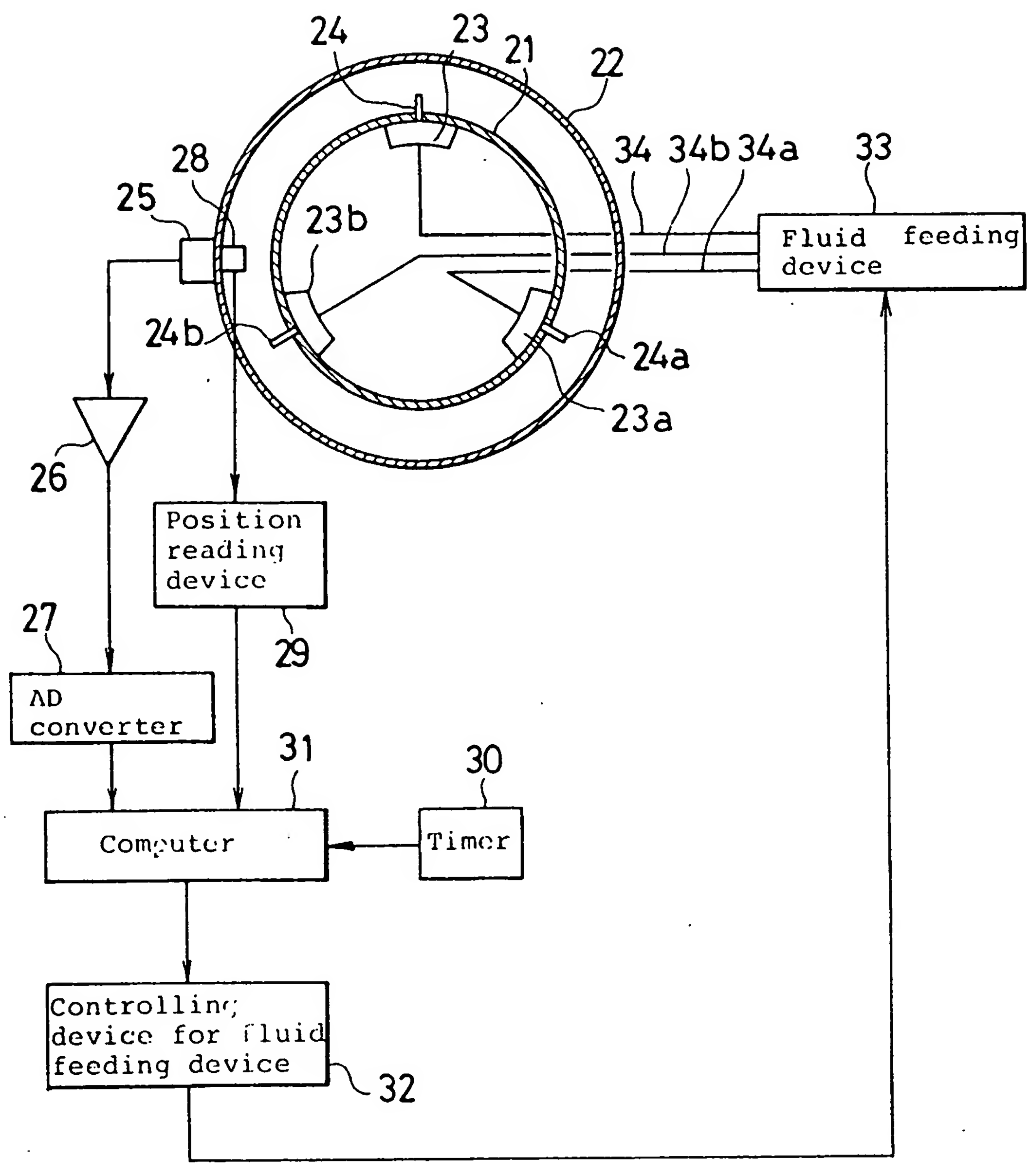

24
23
21
22
34
34b
34a
33
28
25
23b
Fluid feeding device
24b
24a
23a
26
Position reading device
29
27
AD converter
31
30
Computer
Timer
Controlling device for fluid feeding device
32

FIG. 14

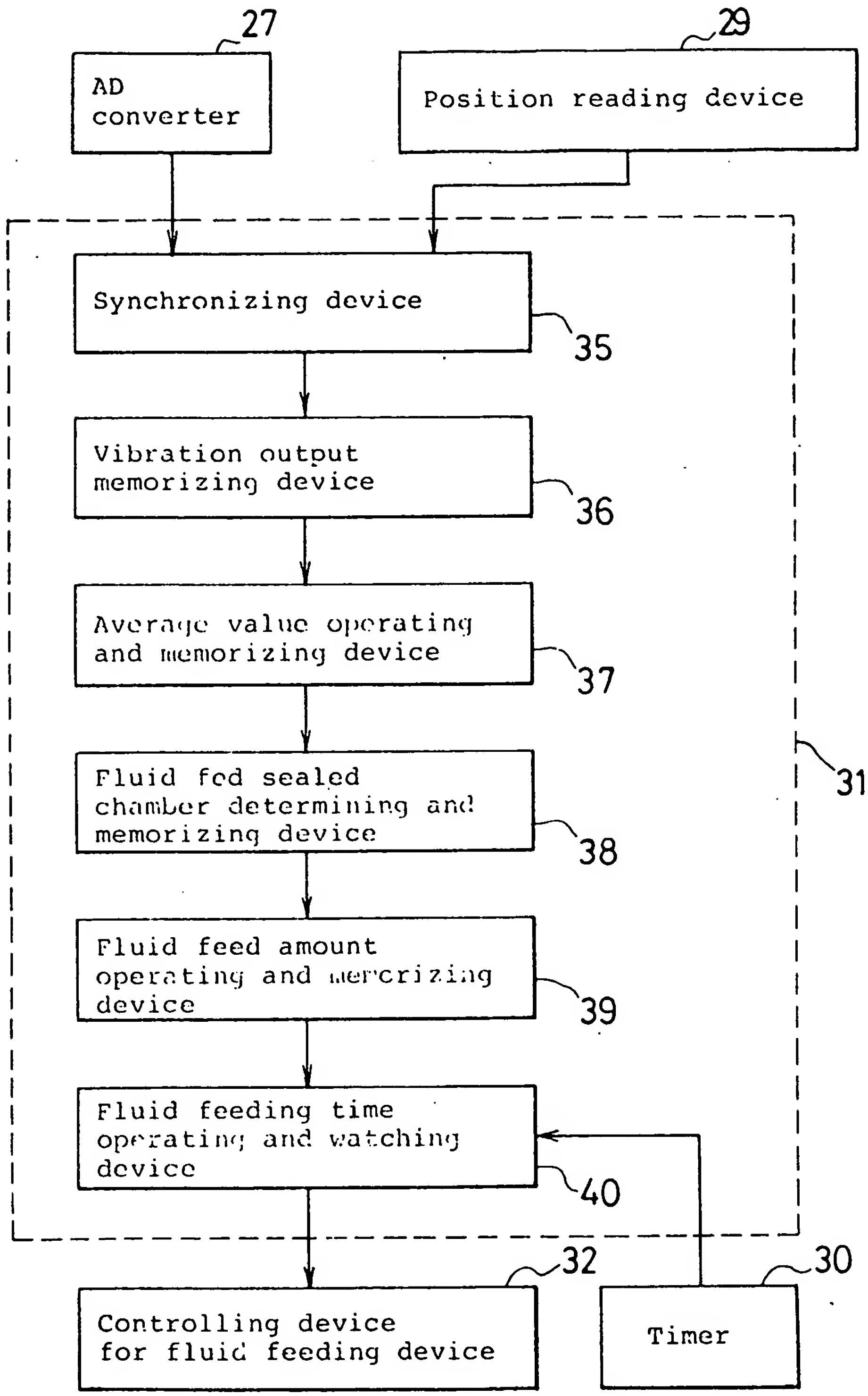

27
AD converter
29
Position reading device
Synchronizing device
35
Vibration output memorizing device
36
Average value operating and memorizing device
37
Fluid fed sealed chamber determining and memorizing device
38
Fluid feed amount operating and memorizing device
39
Fluid feeding time operating and watching device
40
31
32
30
Controlling device for fluid feeding device
Timer

FIG. 15

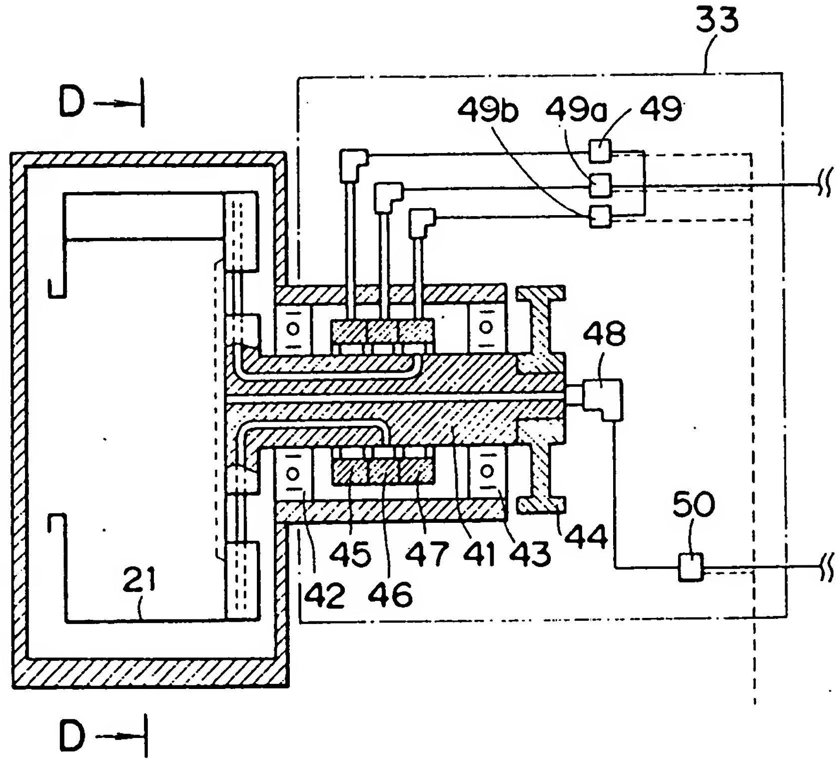


FIG. 16

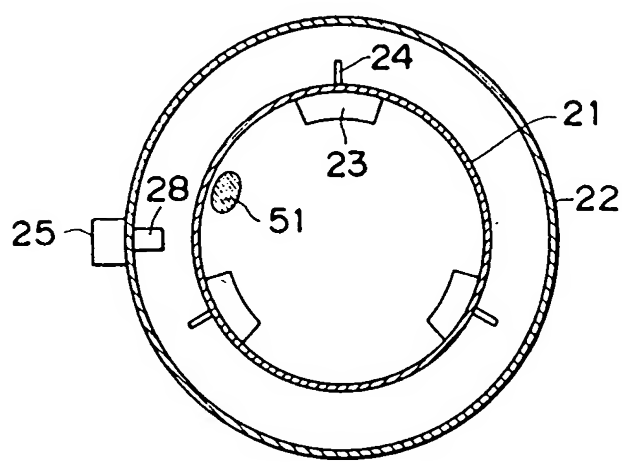


FIG. 17

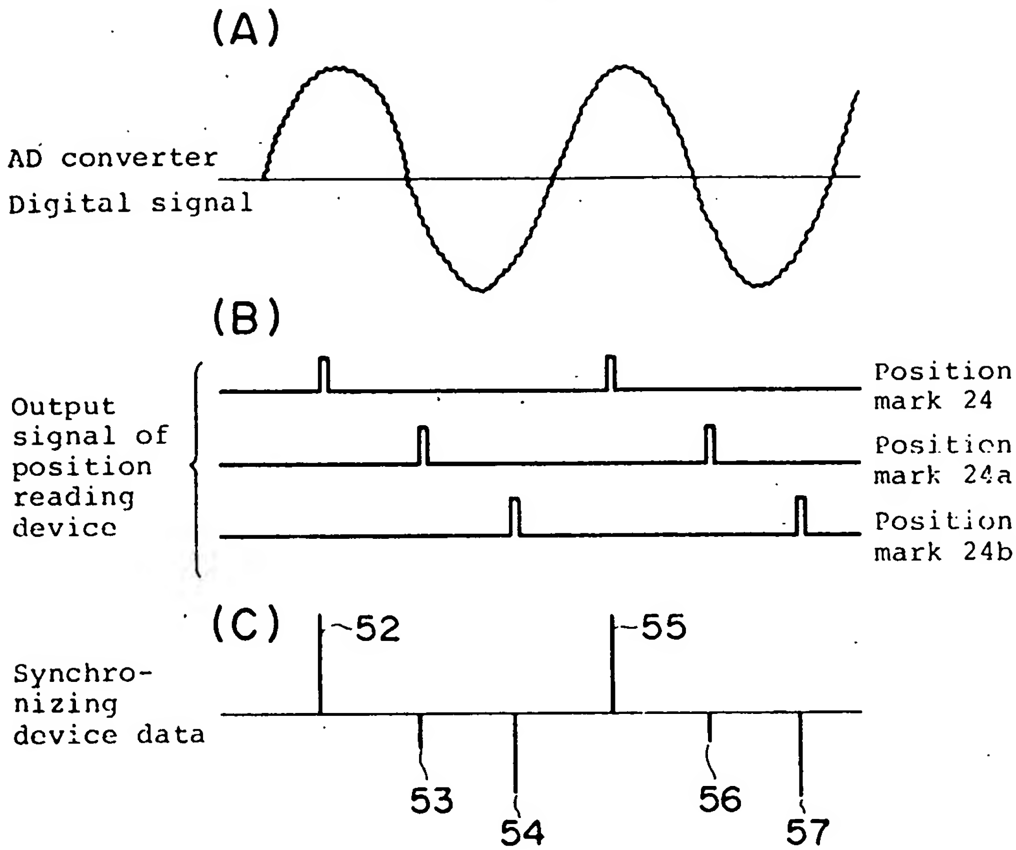

(A)
AD converter
Digital signal
(B)
Output signal of position reading device
Position mark 24
Position mark 24a
Position mark 24b
(C)
Synchro-nizing device data
52
55
53
54
56
57

FIG. 18

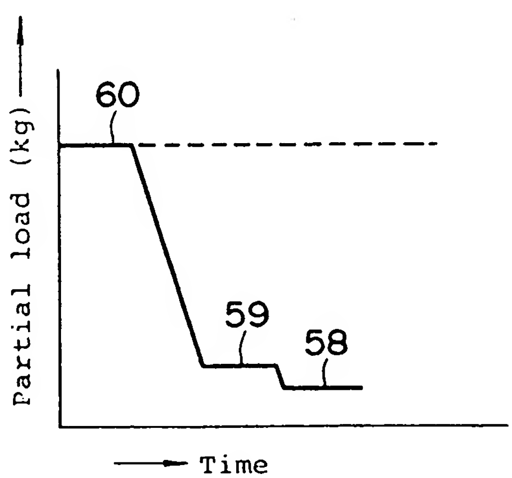

Partial load (kg)
60
59
58
Time

FIG. 19

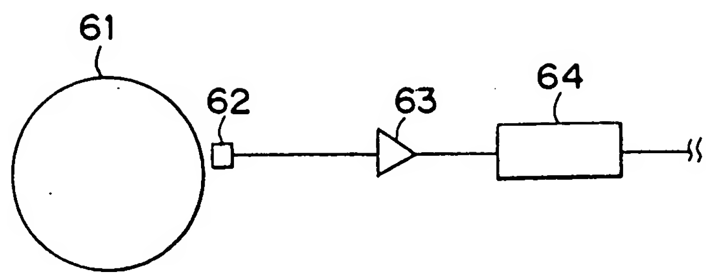
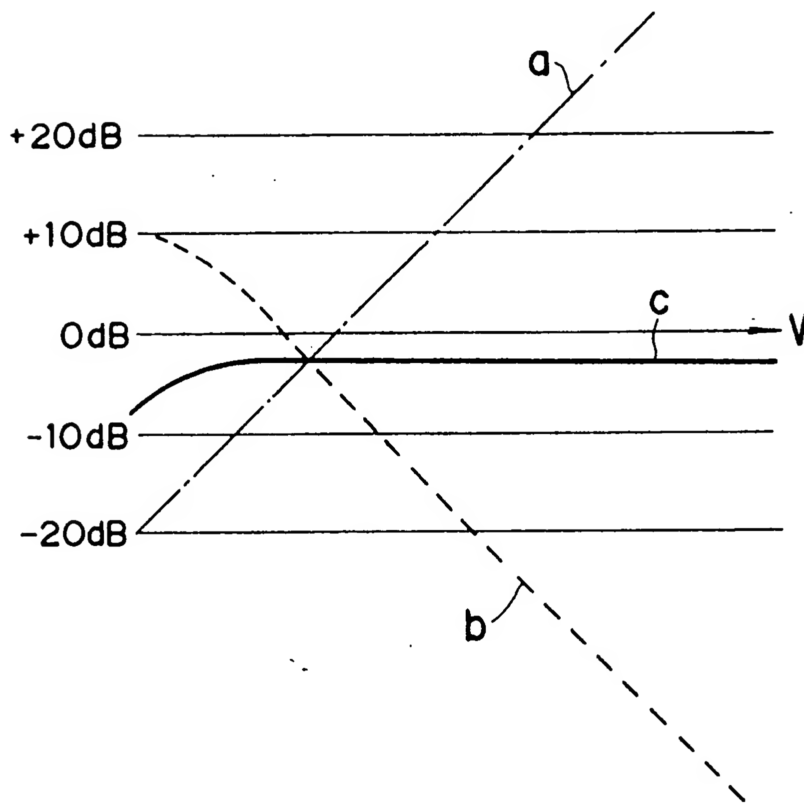


FIG. 20



SPECIFICATION

Dry cleaning machine

This invention relates to improvements in dry cleaning machines.

Usually, in the case of washing clothing with a dry cleaning machine, the clothing is put into a washing drum rotated by a drive source, is washed at a low speed of rotation of the drum and then has the liquid removed by centrifugal force by rotating said washing drum at a high speed. However, there have been defects that, when the liquid is removed, the clothing will be partially present and will not be uniformly distributed within the washing drum, therefore a large vibrating force will be generated by the partial load of the clothing in the washing drum, and not only will the machine life be shortened but also the vibration of the machine will propagate to the surroundings through the installing ground base to cause vibration trouble.

The countermeasures so far taken against vibration problems are largely divided into the following three:

(i) To reduce the partial load of the clothing within the washing drum,

(ii) To interrupt the transmission of vibrations to the machine installing ground base and

(iii) To reinforce the installing ground base.

As an example of the above mentioned countermeasure (i), in a cleaning machine with a horizontal rotary shaft, before the liquid is removed, the clothing within the washing drum is kept at a centrifugal acceleration of substantially 1G in the rotation (balance rotation) for a fixed time. By this countermeasure, the partial load of the clothing can be reduced to substantially half but occasionally a large partial load will be generated. Therefore, it cannot be said to be a sufficient countermeasure.

Further, as an example of the above mentioned countermeasure (ii), it is known to resiliently support the entire machine with an antivibration carriage formed of a spring and damper or to resiliently support only the washing drum part. By such countermeasure, the amount of vibration transmitted from the machine to the ground base will be reduced to a fraction of the conventional amount and the vibration trouble will be eliminated. But, on the other hand, the amplitude of the vibration of the resiliently supported entire machine or washing drum will increase, the piping within the machine will leak and the fastening parts will loosen. Thus, the countermeasure cannot be said to be sufficient.

As an example of the above mentioned countermeasure (iii), the machine is installed on the foundation of a large concrete block to reduce the vibration of the ground base. However, there has been a defect that, in order to obtain a sufficient antivibration effect, the expenses required for the foundation work will be enormous.

The present invention resides in a device for preventing the vibration of a rotary drum of a cleaning machine, comprising a plurality of sealed chambers provided along the periphery of the rotary drum, position detecting members provided respectively to correspond to the above mentioned sealed chambers, a fixed position detecting means detecting the passage of the above mentioned position detecting members, an amplitude detecting means detecting the amplitude of vibration of the rotary drum as synchronized with the detecting signal of the position detecting means, means for selectively feeding fliud to the sealed chambers, and an operating circuit for controlling the amounts of the fluid fed to the chambers on the basis of the detecting signals of the position detecting means and amplitude detecting means.

The present invention will be further explained by way of example with reference to the accompanying drawings in which:–

Figures 1 to 3 are schematic explanatory views of an embodiment of the present invention.

Figure 1 is a general system view showing an essential part as vertically sectioned.

Figure 2 is a sectioned view on line A–A in Fig. 1.

Figure 3 is a sectioned view on line B–B in Fig. 1.

Figure 4 is a graph showing the relations between the rate of revolution of the washing drum and the vibration level transmitted to the ground base.

Figure 5 is a graph showing the detected values of the vibration obtained when there is a partial load of the clothing in the position shown in Fig. 3, and the position signals of the base line.

Figure 6 is a view showing vectors of the balancing load weight by the liquid fed to each sealed chamber.

Figure 7 is a graph showing the relations between the liquid removing time and the weight of the clothing and liquid.

Figure 8 is a view showing an example of the time schedule of the automatic balancing in use of the present invention.

Figure 9 is a graph showing the washing times, partial loads and vibrations levels of a machine employing the present invention and a conventional machine as compared with each other.

Figure 10 is a graph showing another example of the time schedule of the automatic balancing.

Figures 11 and 12 are schematic explanatory views of another embodiment of the present invention.

Figure 11 is a general system view showing an essential part in section.

Figure 12 is a sectioned view on line C–C in Fig. 11.

Figure 13 is a block diagram showing an antivibration system in another embodiment of the present invention.

Figure 14 is a block diagram of the computer in Fig. 13.

Figure 15 is a vertically sectioned view showing the details of the fluid feeding device in Fig. 13.

Figure 16 is a sectioned view on line D–D in Fig. 15.

Figures 17(A), (B) and (C) are signal wave form views of the respective parts in Figs. 13 and 14.

Figure 18 is a diagram showing the antivibration effects of this device.

Figure 19 is a block diagram of a partial load measuring method in the dry cleaning machine of the present invention.

Figure 20 is a characteristic diagram showing the output characteristics of the amplifier and the characteristics and output characteristics of the quadratic analogue filter.

In Figs. 1 and 2, 1 is a rotary washing drum and 2, 2′ and 2″ are a plurality (three in the case of this embodiment) of sealed chambers arranged at regular intervals along the outer periphery of said washing drum to hold a balancing liquid. The rotary shaft 3 of the washing drum 1 is rotatably borne by bearing 4 and 5, is to be rotated by a suitable drive source (not illustrated) through a pulley 6 secured to its outer end and is to rotate in a predetermined direction the washing drum 1 secured to its inner end together with the sealed chambers 2, 2′ and 2″.

7, 8 and 9 are rotary joints for the balancing liquid arranged on the outer periphery of the rotary shaft 3 as shown in Fig. 1. 10 is a rotary joint for air, 11, 11′ and 11″ are liquid paths provided along the axial direction (the direction perpendicular to the paper surface in Fig. 2) within the rotary shaft 3 as shown in Fig. 2. 12 is an air path provided along the axial direction in the center of the rotary shaft 3 and communicating at the outer end with the above mentioned rotary joint 10 and at the inner end with the above mentioned sealed chambers 2, 2′ and 2″. 13 is a vibration detecting means (vibration detector) fitted outside the top of a casing K enclosing the washing drum 1. The vibration due to the partial load 14 of the clothing within the washing drum 1 is to be detected by this vibration detecting means 13. (See Fig. 3)

15 is a base point detector fitted to the casing K as shown in Fig. 1. Signals indicating passage of the base point on the washing drum 1 are to be given by this base point detector 15. 16 is a computer electrically connected to the above mentioned vibration detecting means 13, valves 17, 17′ and 17″ for the liquid and a valve 18 for air.

The valves 17, 17′ and 17″ for the liquid are arranged in pipes communicating respectively with the above mentioned sealed chambers 2, 2′ and 2″ so that, when the respective valves 17, 17′ and 17″ are opened by the output of the computer 16 for a required time, required amounts of the liquid may be introduced into the above mentioned respective sealed chambers.

Further, after the liquid is removed from the clothing, while the liquid within the respective sealed chambers 2, 2′ and 2″ is subjected to a centrifugal acceleration more than 1G, the valve 18 for air will open, compressed air will be fed under pressure into the respective sealed chambers 2, 2′ and 2″ through the rotary join 10 for air and the air path 12 and the liquid within the respective sealed chambers 2, 2′ and 2″ will be forcibly discharged out of the chambers.

An embodiment of the dry cleaning machine of the present invention is formed as mentioned above. First of all, the vibration is measured at a rate of revolution (intermediate liquid removing speed) of the washing drum at which the centrifugal acceleration given to the clothing within the washing drum is larger than 1G and the vibration is so low as not to be a problem. Fig. 5 shows the detected values of the vibration and base point position signals by the vibration detector 13 and base point detector 15 obtained when the partial load of the clothing is in the position 14 shown in Fig. 3. In the drawing, T denotes the time in which the washing drum makes one rotation and t denotes the time difference between the vibration maximum value detection and base point detection. From Fig. 5, the size of the partial load and the angle θ between the base point and partial load are determined as follows:

Partial load $= C \times E$

where C: Constant determined by experiments and

E: Value of the vibration amplitude as converted to an electric amount.

Angle θ (rad.) $= \alpha - t/T \times 2\pi$

where α: Angle between the base point detector and vibration detector.

The amounts of the liquid to be introduced into the respective sealed chambers 2, 2′ and 2″

provided on the outer periphery of the washing drum in order to balance this partial load are obtained by computing the vectors shown in Fig. 6.

In Fig. 6, UB denotes the partial load (in kg.) of the clothing, F denotes the weight (in kg.) of the balancing load by the liquid entering the chamber 2 (F = 0 in Fig. 6), F' denotes the weight (in kg.) of the balancing load by the liquid entering the chamber 2' and F'' denotes the weight (in kg.) of the balancing load by the liquid entering the chamber 2''.

As shown in Fig. 7, at the intermediate liquid removing drum speed, the clothing contains a large amount of liquid and the amount of the partial load is larger than at the time of the shift to the liquid removing speed. In the example of the time schedule of the automatic balancing shown in Fig. 8, the liquid is balanced with the partial load before the drum speed shifts to the liquid removing speed from the intermediate liquid removing speed. The balancing loads P, P' and P'' by the liquid to be put into the respective chambers 2, 2' and 2'' when the drum speed is shifted to the liquid removing speed are determined as follows:

$P = K \times F$,

$P' = K \times F'$ and

$P'' = K \times F''$

where K is a constant determined by experiments.

The amounts of the liquid to be put into the respective chambers 2, 2' and 2'' are computed by the computer 16 from these balancing load values and the liquid is put into the respective chambers 2, 2' and 2'' by opening the respective valves 17, 17' and 17'' for the required time to correct the imbalance caused by the partial load.

This operation is effected two or three times as required. When the remaining partial load is reduced to less than a predetermined value, the speed is shifted to the liquid removing speed. The predetermined value so called here is not a constant value but a value obtained by multiplying the first detected partial load ($C \times E$) by a constant less than 1.

After the speed has been raised to the liquid removing speed, the liquid contained in the clothing will be further removed and the remaining partial load will become large again. Therefore, the vibration is measured at the liquid removing speed to correct the unbalance.

After the end of the liquid removal, the speed is reduced to the intermediate liquid removing speed. While the liquid within the respective chambers 2, 2' and 2'' is held against the outer walls, the respective valves 17, 17' and 17'' are opened, compressed air is fed into the respective chambers 2, 2' and 2'' and the liquid is carried out of the respective chambers.

Fig. 10 shows another example of the time schedule of the automatic balancing of the cleaning machine to which the present invention is applied. In this example, as soon as the washing ends, the speed is raised to the liquid removing speed and imbalance is corrected. In this case, the amounts of the liquid to be put into the respective chambers 2, 2' and 2'' are computed from the values of the above described balancing loads F, F' and F'', the liquid is put into the respective chambers by opening the respective valves 17, 17' and 17'' for the required time and the imbalance can be corrected.

Fig. 9 shows the difference in the practical effects between the cleaning machines to which the present invention is applied and a conventional machine. In the graph, the solid line represents the remaining unbalanced weight in operation of the present invention, the broken line represents the remaining unbalanced weight of the conventional machine, the one-dot chain line represents the ground base vibration level in operation of the present invention and the two-dot chain line represents the ground base vibration level of the conventional machine. As can be seen in this graph, according to the present invention, the remaining unbalanced weight reduces to less than 1/5 that of the conventional machine, the ground base vibration level decreases by more than 14 dB and the ground base vibration problems can be perfectly solved.

After the end of the liquid removal, the liquid in the respective sealed chambers 2, 2' and 2'' is forcibly discharged out of the chambers. Therefore, in a cleaning machine of a type in which, after the liquid is removed, the clothing is dried with an air flow, there is the advantage of consuming no excess heat.

In the above mentioned embodiment, it is possible that the air path 12 is made a liquid path, the valves 17, 17' and 17'' are converted to be for compressed air, a liquid is fed in advance into the sealed chambers 2, 2a and 2b through the rotary joint 10 and path 12, compressed air is fed into the respective chambers through the valves 17, 17' and 17'' according to the signal obtained from the computer 16 and appropriate amounts of the liquid in the respective chambers are thereby discharged to correct the imbalance.

Another embodiment of the dry cleaning machine of the present invention is shown in Figs. 11 and 12. This is an embodiment wherein, in the embodiment shown in Figs. 1 and 2, predetermined amounts of the liquid are enclosed in advance in the respective sealed chambers 2, 2a and 2b which are made to communicate with one another through communicating pipes 19, 19a and 19b and the valves 17, 17' and 17'' are made for air. The valves for air are opened and closed by the signal from the computer 16 and predetermined amounts of compressed air are thereby fed into the respective sealed chambers 2, 2a and 2b to adjust the

amounts of the fluid in the respective sealed chambers. Thereby, the rotary joint 10 for air, air path 12 and valve 18 for air are eliminated.

In each sealed chamber, liquid of about 2/3 the volume of the chamber is enclosed. When the above mentioned valves 17, 17' and 17'' are opened for a fixed time, the air pressures in the respective chambers will vary and the liquid in the respective chambers will be able to be moved between the respective chambers.

Figs. 13 to 18 illustrate a rotary drum vibration preventing device characterized by comprising a plurality of sealed chambers provided along the periphery of a rotary drum, position detecting members provided respectively to correspond to the above mentioned sealed chambers, a fixed position detecting means for detecting the passage of the above mentioned position detecting members, and amplitude detecting means detecting the amplitude of the above mentioned rotary drum as synchronized with the detecting signal of the above mentioned position detecting means, the sealed chambers being fed with a fluid, an operating circuit operating the amounts of the fed fluid on the basis of the detecting signals of the above mentioned position detecting means and amplitude detecting means, and a fluid feeding means selectively feeding the fluid to the above mentioned sealed chambers on the basis of the output of the above mentioned operating circuit.

First, in Figs. 13 to 16, 21 is a rotary drum coaxially loosely inserted in a fixed drum 22, 23, 23a and 23b are sealed chambers of the same shape secured respectively at center angles of 120 degrees along the periphery of the rotary drum 21, 24, 24a and 24b are position marks respectively provided to project on the sealed chambers 23, 23a and 23b and rotating integrally with the rotary drum 21, 25 is a vibration detector provided on the fixed drum 22 and detecting the vibration of the rotary drum 21, 26 is an amplifier amplifying the output of the vibration detector 25, 27 is and Ad converter digitally converting the output of the amplifier 26, 28 is a position detector provided in the same position as the vibration detector 25 on the fixed drum 22 for detecting the passage of the position marks 24, 24a and 24b and 29 is a position reading device receiving the output of the position detector 28 and reading the distinction of the position marks 24, 24a and 24b.

31 is a computer receiving the respective outputs of the AD converter 27, position reading device 29 and a timer 30 and operating the sealed chambers to which the fluid is to be fed in the below mentioned manner and the amounts of the fed fluid. 32 is a controlling device controlling a fluid feeding device 33 with the output of the computer 31.

34, 34a and 34b are pipe lines feeding the fluid respectively to the sealed chambers 23, 23a and 23b from the fluid feeding device 33.

35 is a synchronizing device which inputs and outputs the digital signal from the AD converter 27 only when the output signal of the position reading device 29 is received. 36 is a vibration output memorizing device memorizing the data from the AD converter 27 received by the synchronizing device 35. 37 is an average value operating and memorizing device operating and memorizing the respective average vibration amplitude values of the position marks 24, 24a and 24b from the data output from the vibration output memorizing device 36. 38 is a fluid fed sealed chamber determining and memorizing device determining and memorizing the sealed chamber to be fed with the fluid to compensate the imbalance of the rotary drum, from the average vibration amplitude output of the average value operating and memorizing device 37. 39 is a fluid feed amount operating and memorizing device operating and memorizing the fluid amount to be fed to the fluid fed sealed chamber from the average vibration amplitude output of the average value operating and memorizing device 37 and the output of the fluid fed sealed chamber determining and memorizing device 38. 40 is a fluid feeding time operating and watching device operating the operating time of the fluid feeding device 33 to feed the fluid fed sealed chamber with the fed fluid amount determined by the fluid feed amount operating and memorizing device 39 and watching that, by the timer 30, the fluid feeding device controlling device 32 puts out the above mentioned operating time operating signal to the fluid feeding device 33.

41 is a hollow shaft coaxially journalled in the fixed drum 22 by bearings 42 and 43, secured at one end to the axis of the rotary drum 21 and fitted at the other end with a pulley 44. The hollow shaft 41 is provided with fluid paths forming pipe lines 34, 34a and 34b communicating respectively with the sealed chambers 23, 23a and 23b.

45, 46 and 47 are rotary joints fluid-tightly enclosing the hollow shaft 41, fixed to the fixed drum 22 side and communicating respectively with the pipe lines 34, 34a and 34b. 48 is a rotary joint for air attached to the right hand end of the hollow shaft 41. 49, 49a and 49b are respective fluid-controlling electromagnetic valves. 50 is an air-controlling electromagnetic valve. 51 (Fig. 16) is an outer peripheral equivalent partial load (called a partial load hereinafter) generated by the rotation of the rotary drum 21.

In such device, when the rotary drum 21 rotates, the vibration of the rotary drum 21 caused by the partial load 51 generated as synchronized with the rotation of the rotary drum 21 will be detected by the vibration detector 25, amplified by the amplifier 26, converted to a digital

signal by the AD converter 27 and will then enter the computer 31.

The position detector 28 will distinguish the detecting signals by the position markers 24, 24a and 24b of the rotary drum 21 and the signals will be matched through the position reading device 29 and will then enter the computer 31.

As shown in Fig. 14, the digital signal of the AD converter 27 input to the synchronizing device 35 and the output signal of the position reading device 29 will be respectively of the wave forms shown in Figs. 17(A) and (B). The output of the synchronizing device 35, outputting the output of the AD converter 27 only when the output signal of the position reading device 29 is present, will be of the wave form shown in Fig. 17(C).

In such case, if the data 52, 53, 54, 55, 56 and 57 received by the synchronizing device 35 are made respectively x_{11}, x_{21}, x_{31}, x_{12}, x_{22} and x_{32}, the data obtained at the nth time will be represented by x_{1n}, x_{2n} and x_{3n}. Here, x_{1i} (i = 1 to n) is a vibration amplitude value corresponding to the position mark 24 in Fig. 13. In the same manner, x_{2i} (i = 1 to n) and x_{3i}(i = 1 to n) are vibration amplitudes values corresponding respectively to the position marks 24a and 24b.

The average vibration amplitude is operated in the average value operating and memorizing device 37 in Fig. 14 fundamentally by the below mentioned formulas (1) to (3). However, in the device of this embodiment, for convenience sake, as the vibration detected by the vibration detector 25 is represented by $y = A \sin(\omega t + \theta)$, the following formulas (4) to (6) are used:

$$\bar{x}_1 = (\sum_{i=1}^{n} X_{1i})/n \qquad (1)$$

$$\bar{X}_2 = (\sum_{i=1}^{n} X_{2i})/n \qquad (2)$$

$$\bar{X}_3 = (\sum_{i=1}^{n} X_{3i})/n \qquad (3)$$

$$X_1 = \bar{x}_1 - d/3 \qquad (4)$$

$$X_2 = \bar{x}_2 - d/3 \qquad (5)$$

$$X_3 = \bar{x}_3 - d/3 \qquad (6)$$

where $d = \bar{x}_1 + \bar{x}_2 + \bar{x}_3$ (7)

In this embodiment, the average vibration amplitude values X_1, X_2 and X_3 represent respectively the values when detected of the position marks 24, 24a and 24b.

The fluid fed sealed chamber determining and memorizing device 38 in Fig. 14 will determine to feed the fluid to the other sealed chambers than the sealed chamber (23, 23a or 23b) corresponding to the position mark showing the maximum value X_m (m = 1, 2 or 3) among X_1, X_2 and X_3. For example, if X_1 is larger than X_2 and X_3, it will be determined to feed the fluid to the other sealed chambers 23a and 23b than the sealed chamber 23 corresponding to the position mark 24 corresponding to X_1.

The fluid feed amount operating and memorizing device 39 is to operate the fluid feed amounts by putting in X_1, X_2 and X_3. In the above embodiment, they will be as in the following formulas (8) to (10).

Amount of fluid fed to the sealed chamber

$$23a = k\,x\{-2/3(2X_2 + X_3)\} \qquad (8)$$

Amount of fluid fed to the sealed chamber

$$23b = k\,x\{-2/3(2X_3 + X_2)\} \qquad (9)$$

Amount of fluid fed to the sealed chamber

$$23 = 0 \qquad (10)$$

where k is a fluid feed amount converting coefficient and the values within the parentheses { } of the formulas (8) and (9) are represented by the voltage values or numbers of bits, are

therefore converted to the volumes or weights of the fluid and are memorized.

The fluid feeding time operating and watching device 40 will convert the fed fluid amount to the operating time of the electromagnetic valve. The fluid feeding device controlling device 32 will switch on and off the electromagnetic valves 49, 49a and 49b. The operating signal will be put out by the timer 30 to the fluid feeding device 33 for the operating time. Therefore, the fed fluid amounts of the fluid will be fed into the sealed chambers 23, 23a and 23b respectively through the pipe lines 34, 34a and 34b and the rotary drum 21 will be balanced.

In Fig. 18, the solid line represents the antivibration effect of the present invention. The partial load by the present invention will reduce from the level 60 to level 59 and from level 59 to level 58 with the lapse of time. The broken line represents the partial load in case the present invention is not worked.

In the dry cleaning machine of the present invention, the partial load of the washing drum can be measured by a method of measuring the partial load wherein the vibration of the drum is taken out as a vibrating force F represented by the following formula (11) by using an acceleration meter, then this output signal is amplified and then only the signal corresponding to the partial load m is taken out through a quadratic analogue filter having the characteristics of the below mentioned formula (12):

$$F = mr\omega^2 \qquad (11)$$

where F is a vibrating force, r is a radius of the drum and ω is an angular velocity and

$$(K_A\omega^2_o)/(\omega^2_o + 2\xi\omega_o\overline{2\pi jf} + \overline{2\pi jf^2}) \qquad (12)$$

where K_A is an adjusting coefficient, ω_o is an interrupted frequency, ξ is a tamping coefficient, f is a frequency and j is $\sqrt{-1}$.

Conventionally, in the case of measuring this kind of rotary drum, the vibration of the rotary drum is measured and the partial load is measured on the basis of this measured value. That is to say, the acceleration meter is used to measure the vibration of the rotary drum. The output signal is obtained as proportional to the vibrating force $F = mr\omega^2$ where F is a vibrating force, m is an equivalent concentrated partial load (which shall be called a partial load hereinafter), r is a radius of the rotary drum and ω is an angular velocity of the rotary drum. Therefore, in order to measure the partial load m, it is necessary to cancel ω. Particularly, in case the angular velocity of the rotary drum varies, the correction by the angular velocity will have to be made and will be inconvenient. Further, as the output signal of the acceleration meter is proportional to the square of the angular velocity of the rotary drum, there is a defect that, if the angular velocity of the rotary drum is small, the measured degree will be low.

By the above mentioned method, the partial load of the rotary drum can be easily precisely detected irrespective of the angular velocity.

The method will be explained in the following with reference to Figs. 19 and 20.

First, the vibration of the rotary drum is taken out as a vibrating force F by using an acceleration meter 62. The vibrating force F is represented by the following formula:

$$F = mr\omega^2$$

where r is the radius of the rotary drum and ω is the angular velocity of the rotary drum.

Then, the signal detected by the acceleration meter is amplified through an amplifier. The output characteristic of this amplifier 63 is proportional to the angular velocity of the rotary drum as shown by the straight line a in Fig. 20.

The output signal of the amplifier 63 is sent to a quadratic analogue filter 64 which has a characteristic of the following formula:

$$(K_A \cdot \omega^2_o)/(\omega^2_o + 2\xi_o\overline{2\pi jf} + \overline{2\pi jf^2})$$

where K_A is an adjusting coefficient, ω_o is an interrupted frequency, ξ is a tamping coefficient and f is a frequency. This characteristic is graphed as the curve b in Fig. 20.

The signal having passed through this quadratic analogue filter 64 shows such output characteristic as is shown by the curve c in Fig. 20. Therefore, if the interrupted frequency ω^o and frequency f are so selected that the angular velocity of the rotary drum 61 is on the flat part of the curve c, the amplitude value shown by the output signal of the quadratic analogue filter 64 will be obtained as proportional to the partial load m irrespective of the angular velocity of the rotary drum 61.

As in the above, according to this method, by using the quadratic analogue filter, the amplitude value proportional to the partial load of the rotary drum is obtained without making a correction for the angular velocity and, if the angular velocity is low, the measuring precision

will improve.

CLAIMS

1. A device for preventing the vibration of a rotary drum of a cleaning machine, comprising a plurality of sealed chambers provided along the periphery of the rotary drum, position detecting members provided respectively to correspond to the above mentioned sealed chambers, a fixed position detecting means detecting the passage of the above mentioned position detecting members, an amplitude detecting means detecting the amplitude of vibration of rotary drum as synchronized with the detecting signal of the position detecting means, means for selectively feeding fliud to the sealed chambers, and an operating circuit for controlling the amounts of the fluid fed to the chambers on the basis of the detecting signals of the position detecting means and amplitude detecting means.

2. A device as claimed in claim 1 including an accelerometer for detecting vibration of the drum, an amplifier connected to the accelerometer and a quadratic analogue filter connected the amplifier and having the characteristic

$$(K_A\omega^2{}_o)/(\omega^2{}_o + 2\xi\omega_o\overline{2\pi jf} + \overline{2\pi jf^2}$$

where K_A is an adjusting coefficient, ω_o is an interrupted frequency, ξ is a tamping coefficient, f is a frequency and j is $\sqrt{-1}$, whereby in operation the vibration of the drum is taken out as a vibrating force F represented by

$$F = mr\omega^2$$

where r and ω represent the radius and angular velocity of the drum and m is the partial load in the drum and the output signal of the filter represents the value of m.

3. A device as claimed in claims 1 or 2 further including means for feeding air under pressure to the said chambers.

4. Means for preventing vibration of a rotary drum, substantially as herein described with reference to Figs. 13 to 18 of the accompanying drawings.

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